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The Competitive Ability of *Avena* spp. and *Alopecurus myosuroides* Huds. Influenced by Different Wheat (*Triticum aestivum*) Cultivars

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Abstract: Field experiments were conducted at Havza and Gelemen to evaluate the effect of different densities of *Avena* spp. and *Alopecurus myosuroides* Huds. on wheat cultivars Bezostaja and Kate-A-I. As expected the semi-dwarf cultivar Bezostaja was shorter than Kate-A-I in all weed densities, indicating that plant height was not correlated with competitiveness under the experimental conditions. The mean yields of Bezostaja and Kate-A-I in the weed-free plots in 2000-2001were 3420 kg ha^{-1} and 3360 kg ha^{-1}, respectively. Both species caused decreases in wheat yield with increasing density. While 20 *Avena* spp. per square reduced the yield by 13.3% in Bezostaja, yield losses of 18.6% were observed in Kate-A-I for the same density. The competitive ability of *Avena* spp. with wheat cultivars was highly variable. Taking these yield losses into consideration, the competitive ability of Bezostaja with *Avena* spp. was higher than that of Kate-A-I. Similar results of yield loss were also observed in *A. myosuroides*. Wheat shoot dry weights consistently decreased with increasing weed density. However, there was no correlation between wheat cultivars and weed species. Kate-A-I has more competitive ability for the formation of biomass due to its height.

Key Words: Bezostaja, Kate-A-I, competition, weed management

Avena spp. ve *Alopecurus myosuroides* Huds.'in Farklı Buğday (*Triticum aestivum*) Çeşitleri İle Rekabet Yeteneklerinin Araştırılması

Özet: *Avena* spp. ve *Alopecurus myosuroides*'in farklı buğday çeşitlerine etkisini araştırmak amacıyla yapılan çalışmalar Havza ve Gelemen'de yürütülmüştür. Denemede Bezostaja ve Kate-A-I buğday çeşitleri kullanılmıştır. Beklenildiği gibi daha kısa boylu olan Bezostaja, denemedeki tüm yabancı ot yoğunluklarında Kate-A-I'den daha kısa bulunmuştur. Denemede, bitki boyu ile rekabet yeteneği arasında herhangi bir korelasyon bulunmamıştır. Kontrol parsellerinde 2000-2001 yılında, Bezostaja'nın ortalama verimi 3420 kg ha^{-1} Kate-A-I'in ortalama verimi ise 3360 kg ha^{-1} olarak bulunmuştur. Her iki yabancı ot türünün yoğunluğundaki artışa paralel olarak buğday veriminde bir azalma gözlenmiştir. m^2'de 20 *Avena* spp. Bezostaja'da % 13.3 ürün kaybına neden olurken aynı yoğunlukta Kate-A-I de ise % 18.6 ürün kaybı olmuştur. *Avena* spp.'nin buğday çeşitleri ile rekabet yetenekleri tamamıyla farklı bulunmuştur. Ürün kayıpları göz önüne alındığında Bezostaja'nın *Avena* spp. ile rekabet yeteneği Kate-A-I çeşidinden daha fazla bulunmuştur. *Alopecurus myosuroides* için de benzer sonuçlar elde edilmiştir. Buğday sap kuru ağırlığı yabancı ot yoğunluğu arttıkça azalma göstermiştir, fakat yabancı ot türleri ile buğday çeşitleri arasında herhangi bir korelasyon bulunamamıştır. Kate-A-I çeşidi uzun boylu olduğundan dolayı biomass oluşturma bakımından daha rekabetçi olarak saptanmıştır.

Anahtar Sözcükler: Bezostaja, Kate-A-I, rekabet, yabancı otlarla entegre mücadele

Introduction

Winter wheat is one of the most important agronomic crops in Turkey. As in other countries, *Avena* spp. (wild oat) and *Alopecurus myosuroides* Huds. (blackgrass) are troublesome annual weeds in many regions of Turkey (Holm et al., 1977; O'Donovan et al., 1985; Mennan and Uygur, 1994; Kadıoğlu et al., 1998; Wille et al., 1998; Letouzé and Gasquez, 2000). In spite of extensive herbicide use over the last 20 years, they remain the most ascendant weeds in many wheat fields. Weed

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surveys conducted in different regions of Turkey indicated that both species occurred over 65% of wheat fields surveyed (Uygur et al., 1996). These species may greatly affect wheat yield and quality due to their similar morphology and growing requirements.

Recent agricultural policy changes due to technological advances and reductions in production costs are a primary concern of farmers. There is also the factor of increasing pressure on farmers to reduce herbicide use for both economic and environmental reasons (Brain et al., 1999). Some crucial factors such as anthropogenic elements, weed species and the selection of appropriate crop cultivars may have more effect on weed-crop interaction than do others. Numerous studies have been conducted to evaluate weed competition in different wheat cultivars (Challaiah et al., 1986; İbrahim et al., 1986; Wilson et al., 1990; Koscelny et al., 1991; Ogg and Seefeldt, 1999). It is a well known fact that wheat cultivars give different responses to weed competition. Improved wheat genotypes with aggressive initial growth, rapid canopy cover, and an ability to compete with weeds are an important concern of agronomists with regard to reducing the effects of weeds.

Ogg and Seefeldt (1999) found that cultivars with greater height development rates were the most competitive with *Aegilops cylindrica*. Similarly, the tallest of 4 isolines of a winter wheat cultivar reduced *A. cylindrica* seed production the most, and the grain yield loss caused by *A. cylindrica* was the lowest on a percentage basis (Seefeldt et al., 1999). However, when competing against *A. cylindrica* the tallest isoline did not always have the greatest yield.

Using 9 cultivars of winter wheat, Roberts et al. (2001) concluded that the rye-induced yield loss of Jagger was less than that of other cultivars. Although Triumph 64 was taller at maturity than other cultivars, more yield loss was observed than in Jagger at Orlando. Cudney et al. (1989) found that wheat yield components, grain yield and qualities were reduced by *Avena* spp. In addition, the plant density is an important factor in determining crop yield loss (Spandl et al., 1997).

The objectives of this research were to determine the effect of different densities of *Avena* spp. and *A. myosuroides* on 2 wheat cultivars, Bezostaja and Kate-A-I, and to determine the effects of wheat cultivars on *Avena* spp. and *A. myosuroides* growth.

Materials and Methods

Field experiments were conducted from 2000-2001 to 2001-2002 in 2 locations. The first experimental site was located in Havza and the second in the Black Sea Agriculture Research Institute experimental station (Gelemen) in Samsun. The soil type in the first experimental site is 13.5% sand, 45.4% silt, 41.2% clay and 1.9% organic matter, with pH 7.9. Soil properties of the Gelemen experimental site are 14.2% sand, 45.7% silt, 40.1% clay and 2.5% organic matter, with pH 7.5.

Although both experimental sites are naturally infested with the 2 weeds *Avena* spp. and *A. myosuroides* seeds were sown with wheat in order to reach the desired densities. The wheat cultivars Bezostaja and Kate-A-I were used in the experiment. Bezostaja was sown in Havza on November 8, 2000, and September 29, 2001, and Kate-A-I was sown in Gelemen on November 9, 2000, and September 30, 2001. The seeding rate was 220 kg ha^{-1} to achieve a wheat density target of approximately 325 plants m^{-2}. Rates were adjusted for each variety based on seed size and percentage germination. The plot size was 2 x 1 m in each experimental site. A randomized complete block experimental design with 4 replications was used. One week after the emergence of *Avena* spp. and *A. myosuroides* the densities were adjusted to 0, 1, 5, 10, 20, 40, 80 and 160 plants m^{-2} in Havza. In the other experimental site, weed densities of 0, 1, 5, 10, 20 and 40 plants m^{-2} were established for both species. Desired densities of 80 and 160 plants m^{-2} were not reached at this site. All weeds were marked and all other species that emerged later in the season were removed by hand at biweekly intervals.

Plots were harvested by hand at wheat maturity. Both weed species from 1 m^2 were cut at the soil surface for dry weight analysis. All the samples were weighed fresh, then dried at 60 °C for 3 days and reweighed. All data were analyzed using ANOVA, and the significance ($P < 0.05$) of the main effects of the variety was measured. Means were separated using the LSD test.

Results and Discussion

Wheat heights taken at different vegetation periods until maturity in both years showed significant ($P < 0.05$) differences between cultivars. As expected, the semi-dwarf cultivar Bezostaja was shorter than Kate-A-I at all weed densities (data not shown). Therefore, plant height was not correlated with competitiveness under the experimental conditions. Seefeldt et al. (1999) and Roberts et al. (2001) proposed that environmental conditions may be more important than mature wheat height alone in competition. Many studies related to annual grasses concluded that taller wheat cultivars reduced weed biomass more than did shorter cultivars and thus were more competitive (Blackshaw et al., 1981; Balyan et al., 1991; Ogg and Seefeldt, 1999). Taller wheat cultivars did not always produce the highest yields even in weed-infested plots (Challaiah et al., 1986). Snaydon (1984) suggested that a wheat cultivar's competitive ability may be negatively associated with potential yield. Generally, taller cultivars contribute relatively more resources to the vegetative plant parts than to the grain. Challaiah et al. (1986) concluded that Turkey was the most competitive cultivar on the basis of decreasing *B. tectorum* growth, but that it had poor grain yield. Although other cultivars, Vona and NE 78798 were shorter than Turkey they had grain yields greater than that of Turkey when grown with or without *B. tectorum.* Roberts et al. (2001) indicated that the *S. cereale* induced yield loss of Jagger was less than the yield loss of several other cultivars. Even though Triumph 64 was taller at maturity than the other cultivars, more yield losses were observed in Jagger due to *S. cereale* competition. Although Bezostaja was nearly 10% shorter than the other cultivar, it was more competitive and produced the highest yields in weed-free plots and weed-infested plots in our experiment.

Wheat yields varied from year to year because of differing amounts of rainfall and other ecological factors. The mean yields of Bezostaja and Kate-A-I in the weed-free plots in 2000-2001were 3420 kg ha^{-1} and 3360 kg ha^{-1}, respectively. Both species caused decreases in wheat yield by increasing density (Tables 1 and 2).

The competitive abilities of *Avena* spp. with wheat cultivars were significantly different ($P < 0.05$). While 20 *Avena* spp. per square reduced the yield by 13.3% in Bezostaja, yield losses of 18.6% were observed in Kate-A-I at the same density. Taking these yield losses into consideration the competitive ability of Bezostaja with *Avena* spp. was higher than that of Kate-A-I. The results of similar yield loss were also observed in 2002. Wilson et al. (1990) reported that at low *Avena* spp. densities crop yield would decrease 1% for each additional *Avena* spp. plant per square meter. Singh et al. (1995) stated that yield losses in winter wheat due to *Avena* spp. could change according to the sowing time. They found that yield losses in winter *Avena* spp. infested plots decreased from 60 to 32 to 23%, respectively, for November 10 (97 *Avena* spp. m^{-2}), November 30 (27 *Avena* spp. m^{-2}) and December 20 (9 *Avena* spp. m^{-2}) sowings. In contrast, Chancellor and Peters (1974) found no spring wheat yield reduction in England until *Avena* spp. density reached 150 plants m^{-2}. At low levels of weed infestations, the competitive effect of *Avena* spp. with wheat varieties was insignificant ($P < 0.05$) in both years (Table 1).

A. myosuroides did not significantly ($P < 0.05$) influence wheat yields until its density reached 10 plants m^{-2}. After this density wheat yield decreased linearly in both cultivars. Although both cultivars gave similar responses to *A. myosuroides* competition at low weed densities much greater yield decreases were observed in Kate-A-I varieties than in Bezostaja (Table 2). Roebuck (1987) found that *A. myosuroides* had significant effects on wheat yield as low as 10 plants m^{-2} and that it could reduce yield by 1.0 t ha^{-1} or more depending on crop vigor at a density of 100 plants m^{-2}.

Increasing weed density consistently decreased the shoot dry weights of both wheat cultivars (Figures 1 and 2). This decrease can be explained by diminishing wheat tillering numbers. Our results indicated that there was no correlation neither with shoot dry weights of wheat cultivars or with weed species.

Avena spp. and *A. myosuroides* shoot dry weights were higher in Bezostaja than in Kate-A-I. This indicates that Kate-A-I has more competitive ability for the formation of biomass (Figures 1 and 2). Other studies have shown that taller wheat varieties reduced weed biomass more than did shorter varieties (Challaiah et al., 1986; Balyan et al., 1991; Ogg and Seefeldt, 1999). However, even if taller wheat varieties are more competitive than shorter ones they do not always produce the highest yields in the infested area (Challaiah et al., 1986).

It is well known that competition between wheat varieties and weeds is strongly influenced by the emergence time. If wheat emerges earlier than weeds the relative competitive ability of wheat is increased (O'Donovan et al., 1985; Kropff et al., 1992; Tanji et al.,

Table 1. The effects of *Avena* spp. on yield and wheat shoot dry weight of Bezostaja and Kate-A-I between 2000 and 2002.

Location	Year	Variety	*Avena* spp. density (plants m^{-2})	Yield (t ha^{-1})	Wheat shoot dry weight (g $plant^{-1}$)
Havza	2000-2001	Bezostaja	0	3420 ± 34	11.8 ± 0.68
			1	3455 ± 19	12.0 ± 0.40
			5	3344 ± 40	11.1 ± 0.52
			10	3267 ± 29	11.4 ± 0.52
			20	2966 ± 84	10.3 ± 0.96
			40	2706 ± 73	9.2 ± 0.39
			80	2182 ± 58	8.4 ± 0.31
			160	1718 ± 54	8.6 ± 0.42
			LSD ($P \leq 0.05$)	161	1.49
Gelemen	2000-2001	Kate-A-I	0	3360 ± 32	11.2 ± 0.89
			1	3382 ± 25	11.9 ± 0.54
			5	3311 ± 13	11.2 ± 0.55
			10	3180 ± 66	11.5 ± 1.09
			20	2736 ± 55	9.1 ± 0.30
			40	2522 ± 129	8.4 ± 0.21
			LSD ($P \leq 0.05$)	194	1.88
Havza	2001-2002	Bezostaja	0	4332 ± 64	12.1 ± 0.69
			1	4309 ± 57	12.7 ± 0.44
			5	4125 ± 21	11.7 ± 0.46
			10	3970 ± 18	12.3 ± 0.58
			20	3613 ± 45	11.1 ± 0.51
			40	2730 ± 85	8.8 ± 0.43
			80	2527 ± 39	9.1 ± 0.55
			160	1913 ± 51	6.1 ± 0.44
			LSD ($P \leq 0.05$)	145	1.44
Gelemen	2001-2002	Kate-A-I	0	4107 ± 64	12.10 ± 0.61
			1	4061 ± 48	12.05 ± 0.57
			5	3975 ± 15	11.97 ± 0.94
			10	3854 ± 58	10.42 ± 0.24
			20	3217 ± 25	8.55 ± 0.26
			40	2552 ± 38	7.80 ± 0.21
			LSD ($P \leq 0.05$)	106	1.74

*Data are means ± standard errors

Table 2. The effects of *A. myosuroides* on yield and wheat shoot dry weight of Bezostaja and Kate-A-I between 2000 and 2002.

Location	Year	Variety	*A. myosuroides* density (plants m^{-2})	Yield (t ha^{-1})	Wheat shoot dry weight (g $plant^{-1}$)
Havza	2000-2001	Bezostaja	0	3420 ± 34	11.5 ± 0.37
			1	3445 ± 29	11.9 ± 0.41
			5	3390 ± 24	9.9 ± 0.53
			10	3336 ± 21	11.4 ± 0.45
			20	3138 ± 25	10.7 ± 0.40
			40	3040 ± 61	9.1 ± 0.46
			80	2426 ± 51	8.7 ± 0.20
			160	1960 ± 52	8.9 ± 0.22
			LSD ($P \leq 0.05$)	97	1.33
Gelemen	2000-2001	Kate-A-I	0	3360 ± 32	11.2 ± 0.89
			1	3337 ± 28	11.8 ± 0.24
			5	3340 ± 31	11.7 ± 0.52
			10	3295 ± 43	10.9 ± 0.29
			20	3184 ± 14	9.8 ± 0.45
			40	2842 ± 86	10.2 ± 0.71
			LSD ($P \leq 0.05$)	142	1.61
Havza	2001-2002	Bezostaja	0	4332 ± 64	12.1 ± 0.69
			1	4325 ± 50	10.4 ± 0.24
			5	4230 ± 21	12.7 ± 0.81
			10	4022 ± 41	11.4 ± 0.22
			20	3884 ± 35	11.9 ± 0.57
			40	3603 ± 31	9.8 ± 0.13
			80	3008 ± 39	9.6 ± 0.58
			160	2462 ± 32	9.1 ± 0.49
			LSD ($P \leq 0.05$)	112	1.30
Gelemen	2001-2002	Kate-A-I	0	4107 ± 64	12.10 ± 0.61
			1	4045 ± 13	9.55 ± 0.54
			5	4044 ± 38	11.77 ± 0.20
			10	3841 ± 32	10.80 ± 0.24
			20	3651 ± 25	9.55 ± 0.20
			40	3431 ± 29	6.22 ± 0.42
			LSD ($P \leq 0.05$)	86	1.11

*Data are means ± standard errors

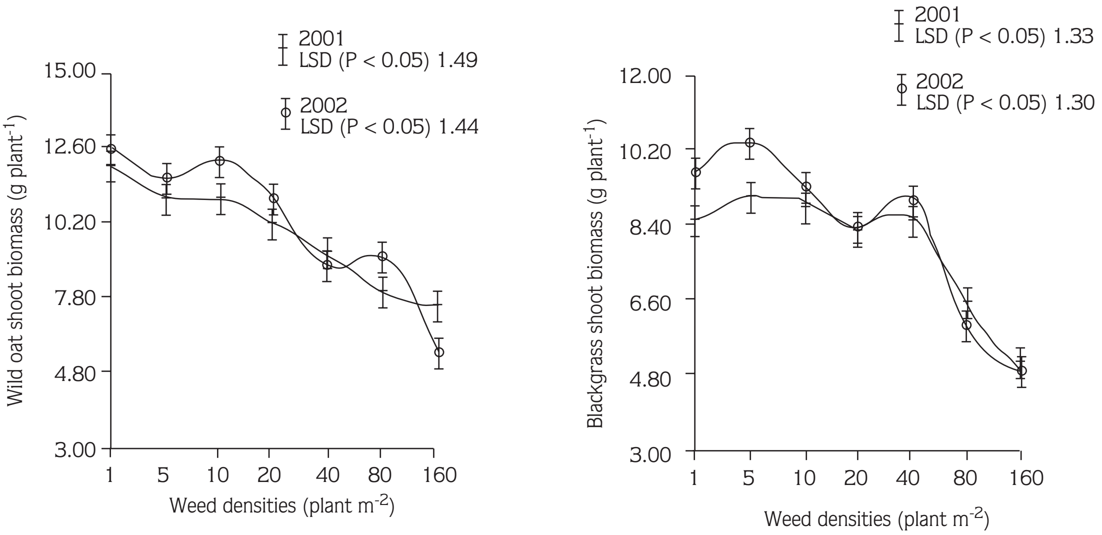

Figure 1. Effect of Bezostaja and different densities of weeds on *Avena* spp. and *Alopecurus myosuroides* shoot dry weight. (Vertical bars represent standard error of the mean).

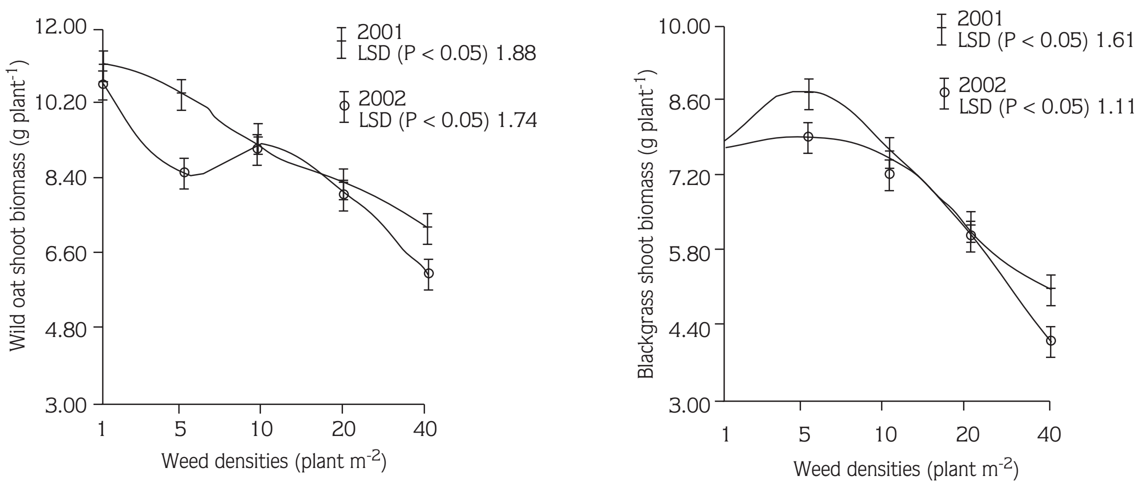

Figure 2. Effect of Kate-A-I and different densities of weeds on *Avena* spp. and *Alopecurus myosuroides* shoot dry weight. (Vertical bars represent standard error of the mean).

1997). The variety Kate-A-I emerged before *Avena* spp. and *A. myosuroides*. Thus, the early emergence of wheat increased its dry weight accumulation in leaves, stems and spikes.

This study indicates that wheat cultivars commonly grown in the Central Black Sea region of Turkey have different competitive abilities with *Avena* spp. and *A. myosuroides*. In particular, the number of resistant populations of *Avena* spp. is increasing and control is becoming more difficult (Uludağ et al. 2001). In most cases annual broadleaf weeds can be easily and cheaply controlled with herbicides. In contrast, the control of grass weeds by herbicides is quite expensive. If Bezostaja were sown at appropriate densities it might well compete with these grass weeds. Thus, the use of herbicides would be minimized. Our findings are also important from this point of view.

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